

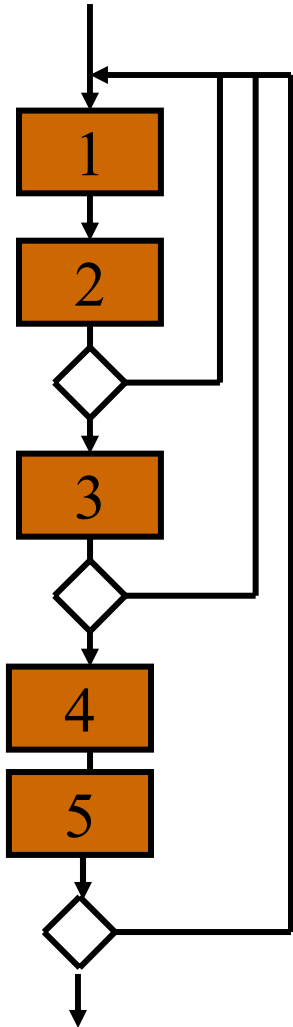
# **Migrating C/C++ Applications to 64-bit on AMD Opteron™ processor-based platforms**

Shel Travis,  
VP of Research, MigraTEC

# Agenda

- The Classic Migration Problems
- MigraTEC's Migration Alternative
- Migration Process Model
- Inventory and Assessment
- 64-bit Upgrade Issues
- Automation with 64Express

# The Migration Problem (#1)



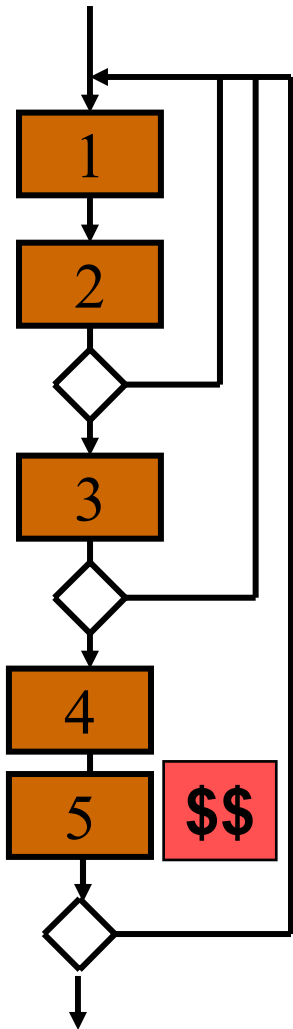
## The Manual Approach

- Compile source files, Eliminate errors & warnings
- Run Lint, Edit to remove meaningful warnings  
*repeat, repeat, repeat, ...*
- Link, Edit file(s) to remove errors and conflicts  
*repeat, repeat, repeat, ...*

## Once the compiler and linker errors are fixed:

- Test to isolate the missed problems
- Debug to find the cause,  
Edit to fix the defect(s)  
go back to step 1  
*repeat, repeat, repeat, ...*

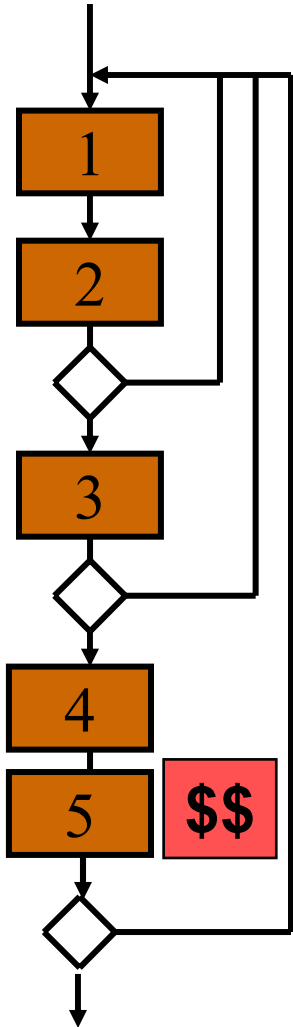
# The Migration Problem (#2)



## The Compiler doesn't find:

- API changes (Functions and Enumerates)
- Constant comparisons to pointers (0xFFFFFFFF)
- 0xFFFFFFFF and -1 are NOT equivalent
- Pointer Allocation using sizeof (DWORD, long, etc)
- Offset access to pointer arrays
- Use of 0x80000000 mask to find system addresses
- Implicit and Explicit Unions of 32 and 64-bit types
- Cross Process / File I/O expansion/truncation
- 32 vs. 64-bit "long" in Windows/Unix common code
- #ifdef ALPHA, etc. as test for 64-bit build
- "Legacy API's" (16-bit support in Windows drivers)
- Non 8 byte boundary Pointer alignment

# The Migration Problem (#3)



## The Required Changes are not enough:

Code can be made to compile/run with small number of critical changes

Example:

pViewer.exe\* MUST have only 12 changes

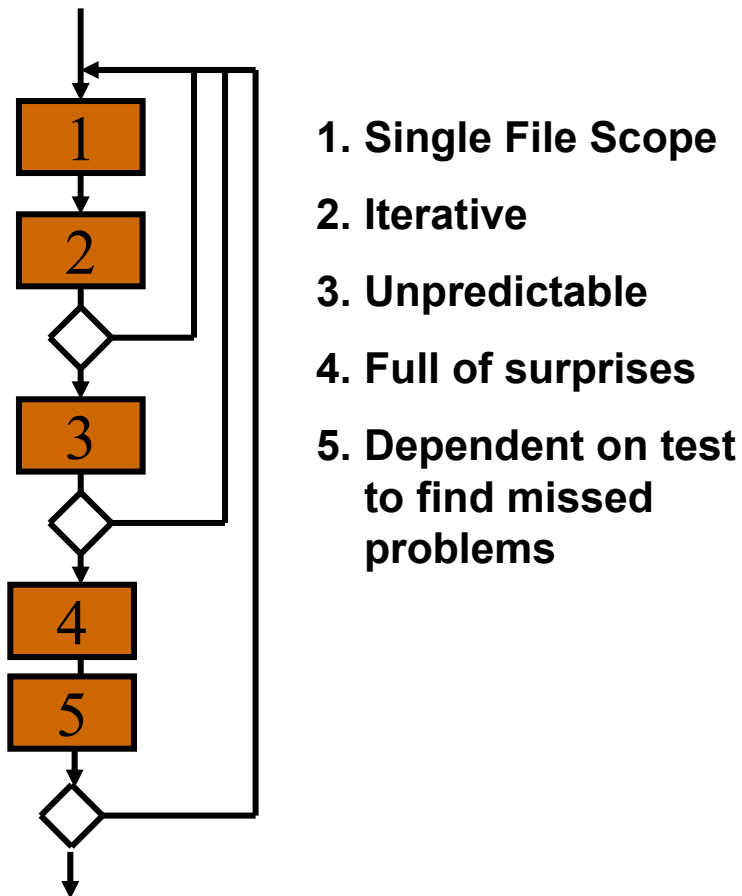
This leaves dozens of compiler warnings!

Few companies will permit release of code with numerous high severity warnings.

*\* Microsoft SDK sample application*

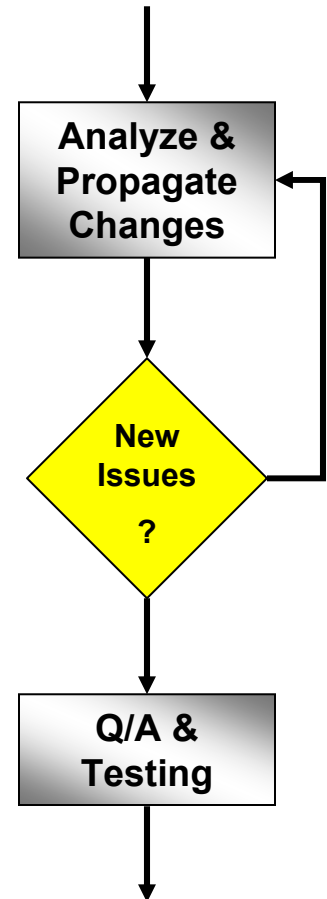
# MigraTEC's Migration Alternative

## Manual



## Automated

1. Automatic analysis of ALL source files
  - In executable AND libraries
  - In ALL communicating applications
2. Complete Detection: Eliminate errors BEFORE Debug
3. Automated Edits: Eliminate entry errors
4. Documented Changes: Focus testing on modified code



# Project Process Model

## **Project Initiation**

Inventory, ROI,  
Risk analysis, Go/no-go

## **Project Planning**

Requirements, Scope, Sizing,  
Resources, QA Specs

## **Code Migration**

Analyze, Remediate, Build

## **Testing/QA**

Unit Test, Correction, Performance Tuning,  
System Test, Acceptance

## Determine project content

### Source code inventory

- Build configurations
- Build tools
- Complete source code
- Third party libraries

## Develop a migration strategy

### Migration impacts

- Build issues – New compiler
- Code issues – distribution and complexity



# Assessment

## Automated Build Capture (with MigraLOG)

```
apache.log - WordPad
File Edit View Insert Format Help

**** MigraLOG V3.0, Copyright 2002 MigraTEC, Inc. ****
SYS: Linux

VAR: AUX_CFLAGS=-DLINUX=2 -DUSE_HSREGEX -DUSE_EXPAT -I./lib/expat-lite `./apaci`
VAR: BASH_ENV=/export/home/dmiller/linux2/.bashrc
VAR: CC=gcc
VAR: EDITOR=vi
VAR: HISTSIZE=1000
VAR: HOME=/export/home/dmiller/linux2
VAR: HOSTNAME=linux2.migratec
VAR: HOSTTYPE=i386
VAR: INPUTRC=/etc/inputrc
VAR: KDEDIR=/usr
VAR: LANG=en_US
VAR: LESSOPEN=|/usr/bin/lesspipe.sh %s
VAR: LOGNAME=dmiller
VAR: LS_COLORS=no=00:fi=00:di=01;34:ln=01;36:pi=40;33:so=01;35:bd=40;33:01:cd=40;33:01:or=01;05;37;41:mi=01;05;37;41:ex=01;32:
*.cmd=01;32:*.exe=01;32:*.com=01;32:*.btm=01;32:*.bat=01;32:*.sh=01;32:*.csh=01;32:*.tar=01;31:*.tgz=01;31:
*.arj=01;31:*.taz=01;31:*.lzh=01;31:*.zip=01;31:*.z=01;31:*.Z=01;31:*.gz=01;31:*.bz2=01;31:*.bz=01;31:*.tz=01;31:
*.rpm=01;31:*.cpio=01;31:*.jpg=01;35:*.gif=01;35:*.bmp=01;35:*.xbm=01;35:*.xpm=01;35:*.png=01;35:*.tif=01;35:
VAR: MACHTYPE=i386-redhat-linux-gnu
VAR: MAIL=/var/spool/mail/dmiller
VAR: MAKEFLAGS= --no-print-directory -- RANLIB=ranlib AUX_CFLAGS=-DLINUX=2 -DUSE_HSREGEX -DUSE_EXPAT\
-I./lib/expat-lite `./apaci` CC=gcc SDP=src/ root= SDP=src/
VAR: MAKELEVEL=4
VAR: MAKEOVERRIDES=${-*command-variables-*}
VAR: MFLAGS= --no-print-directory
VAR: MIGRALOG=/export/home/dmiller/linux2/migralog.ini
VAR: OSTYPE=linux-gnu
VAR: PATH=/export/home/dmiller/linux2/migralog:/usr/kerberos/bin:/usr/local/bin:/bin:/usr/bin:/usr/X11R6/bin:/export/home/dmiller/linu
VAR: PVM_ROOT=/usr/share/pvm3
VAR: PVM_RSH=/usr/bin/rsh
VAR: PWD=/export/home/dmiller/linux2/code/apache/apache_1.3.9/src/regex
VAR: QTDIR=/usr/lib/qt-2.2.0
VAR: RANLIB=ranlib
VAR: REMOTEHOST=dmiller3.migratec.com
```

# Assessment

## Automated Build Capture (with MigraLOG)

```
apache.log - WordPad
File Edit View Insert Format Help

DIR: /export/home/dmiller/linux2/code/apache/apache_1.3.9/src/regex

CMD: gcc -I. -I../os/unix -I../include -DLINUX=2 -DUSE_HSREGEX -DUSE_EXPAT -I../lib/expat-lite -DHTTPD_ROOT="/usr/local/apache"
-DSEUEXEC_BIN="/usr/local/apache/bin/suexec" -DSHARED_CORE_DIR="/usr/local/apache/libexec" -DDEFAULT_PIDLOG="logs/httpd.pid"
-DDEFAULT_SCOREBOARD="logs/httpd.scoreboard" -DDEFAULT_LOCKFILE="logs/httpd.lock" -DDEFAULT_XFERLOG="logs/access_log"
-DDEFAULT_ERRORLOG="logs/error_log" -DTYPES_CONFIG_FILE="conf/mime.types" -DSERVER_CONFIG_FILE="conf/httpd.conf"
-DACCESS_CONFIG_FILE="conf/access.conf" -DRESOURCE_CONFIG_FILE="conf/srm.conf" -DPOIX_MISTAKE -c -o regcomp.o regcomp.c
PTH: /usr/bin/gcc
RET: 0

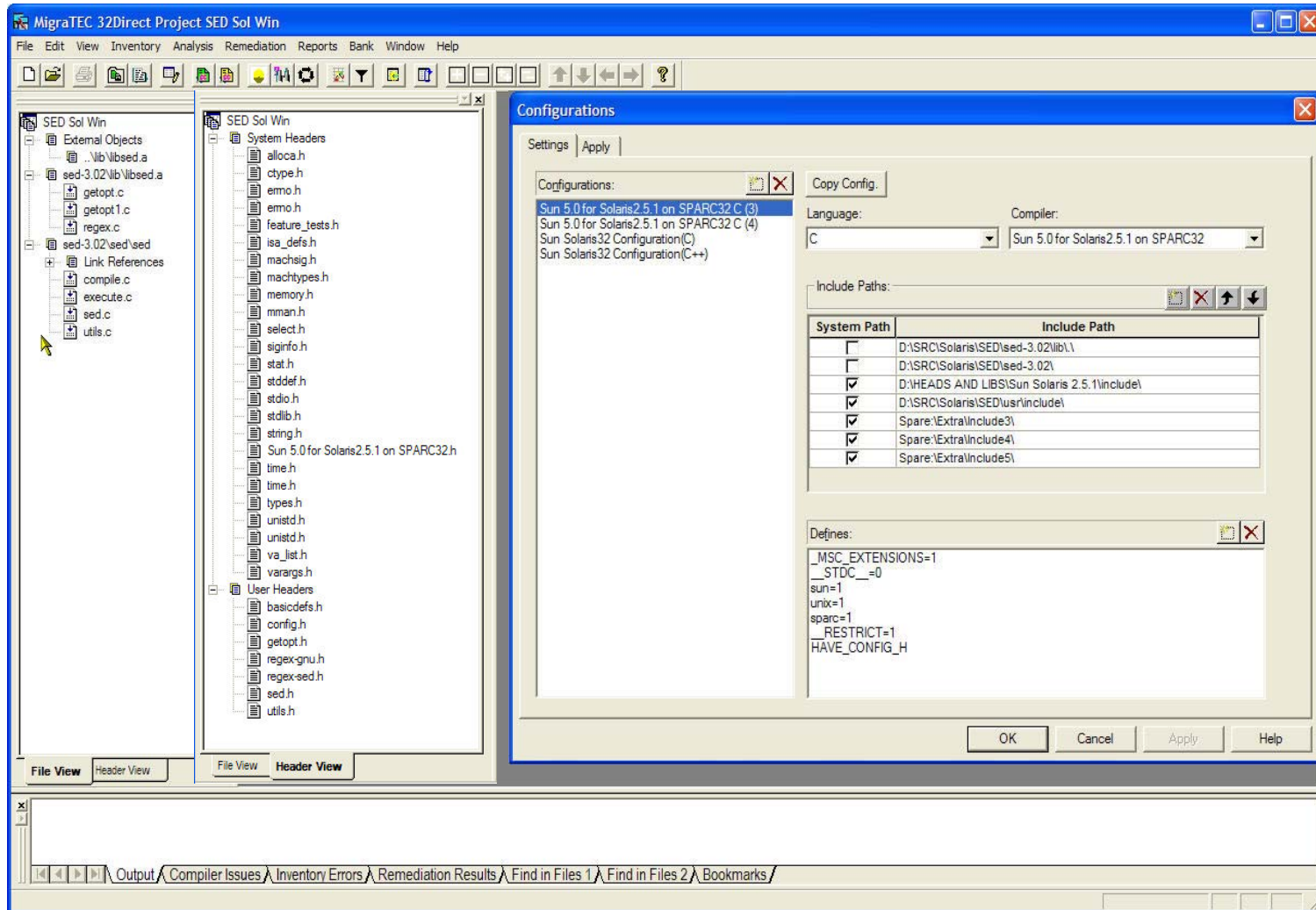
CMD: gcc -I. -I../os/unix -I../include -DLINUX=2 -DUSE_HSREGEX -DUSE_EXPAT -I../lib/expat-lite -DHTTPD_ROOT="/usr/local/apache"
-DSEUEXEC_BIN="/usr/local/apache/bin/suexec" -DSHARED_CORE_DIR="/usr/local/apache/libexec" -DDEFAULT_PIDLOG="logs/httpd.pid"
-DDEFAULT_SCOREBOARD="logs/httpd.scoreboard" -DDEFAULT_LOCKFILE="logs/httpd.lock" -DDEFAULT_XFERLOG="logs/access_log"
-DDEFAULT_ERRORLOG="logs/error_log" -DTYPES_CONFIG_FILE="conf/mime.types" -DSERVER_CONFIG_FILE="conf/httpd.conf"
-DACCESS_CONFIG_FILE="conf/access.conf" -DRESOURCE_CONFIG_FILE="conf/srm.conf" -DPOIX_MISTAKE -c -o regex.o regex.o
PTH: /usr/bin/gcc
RET: 0

CMD: gcc -I. -I../os/unix -I../include -DLINUX=2 -DUSE_HSREGEX -DUSE_EXPAT -I../lib/expat-lite -DHTTPD_ROOT="/usr/local/apache"
-DSEUEXEC_BIN="/usr/local/apache/bin/suexec" -DSHARED_CORE_DIR="/usr/local/apache/libexec" -DDEFAULT_PIDLOG="logs/httpd.pid"
-DDEFAULT_SCOREBOARD="logs/httpd.scoreboard" -DDEFAULT_LOCKFILE="logs/httpd.lock" -DDEFAULT_XFERLOG="logs/access_log"
-DDEFAULT_ERRORLOG="logs/error_log" -DTYPES_CONFIG_FILE="conf/mime.types" -DSERVER_CONFIG_FILE="conf/httpd.conf"
-DACCESS_CONFIG_FILE="conf/access.conf" -DRESOURCE_CONFIG_FILE="conf/srm.conf" -DPOIX_MISTAKE -c -o regerror.o regerror.o
PTH: /usr/bin/gcc
RET: 0

CMD: gcc -I. -I../os/unix -I../include -DLINUX=2 -DUSE_HSREGEX -DUSE_EXPAT -I../lib/expat-lite -DHTTPD_ROOT="/usr/local/apache"
-DSEUEXEC_BIN="/usr/local/apache/bin/suexec" -DSHARED_CORE_DIR="/usr/local/apache/libexec" -DDEFAULT_PIDLOG="logs/httpd.pid"
-DDEFAULT_SCOREBOARD="logs/httpd.scoreboard" -DDEFAULT_LOCKFILE="logs/httpd.lock" -DDEFAULT_XFERLOG="logs/access_log"
-DDEFAULT_ERRORLOG="logs/error_log" -DTYPES_CONFIG_FILE="conf/mime.types" -DSERVER_CONFIG_FILE="conf/httpd.conf"
-DACCESS_CONFIG_FILE="conf/access.conf" -DRESOURCE_CONFIG_FILE="conf/srm.conf" -DPOIX_MISTAKE -c -o regfree.o regfree.o
PTH: /usr/bin/gcc
RET: 0
```



# Project Inventory



# Migration Strategy

- Which data types will be used?
- Backward compatibility?
- Merge changes during migration?
- Developer Training?
- Standards to prevent recreating problems?
- Project segmentation and sequencing?
- Work/Skill assignment?

# Project Process Model

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## **Testing/QA**

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System Test, Acceptance

# Migration Planning

## Assessment

- ✓ Code inventory complete
- ✓ 3rd party and build dependencies
- ✓ Skill needs identified
- ✓ Strategy and requirements known

## Planning

- External dependency availability
- Work assignment based on skill needs
- Work order determined by dependencies

# Project Process Model

## **Project Initiation**

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## **Code Migration**

Analyze, Remediate, Build

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System Test, Acceptance

## What Changes?

### *Memory Model*

LLP64 (aka P64)

LP64 for Unix / Linux

### *API's*

New Interface Definitions

Redefined Interfaces

### *Compiler*

New Command Line Arguments

No embedded assembly



# Memory Model Changes

LLP64 “LongLongPointer64” (Windows)  
(aka P64) *(longlongs and pointers are 64-bit...)*

- Pointers expand to 64-bits
- Runtime APIs require/return 64-bit values

LP64 “LongPointer64” (Linux)  
*(longs and pointers are 64-bit...)*

- Pointers expand to 64-bits
- LONGs expand to 64-bits
- Runtime APIs require/return 64-bit values

*Watch out for shared code!*

# Pointer Expansion => Truncation Issues

Pointers used as Integer

Handles used as LONGs (Windows)

Truncation by CAST

```
int x, iSize;  
x = (int) &y;  
SendMessage ( a, b, wParam, (LONG) hWnd );
```

Truncation by Assignment

```
iSize = cArray.GetSize(); //GetSize returns intptr_t
```

## Issue: Assumptions about the size of a long (Especially in mixed Linux and Windows code.)

Ex. From SED 3.02 (regex-gnu.h)

```
/* The following two types have to be signed and unsigned integer  
   type wide enough to hold a value of a pointer.  For most ANSI  
   compilers ptrdiff_t and size_t should be likely OK.  Still size  
   of these two types is 2 for Microsoft C.  Ugh... */  
typedef long int s_reg_t;  
typedef unsigned long int active_reg_t;
```

### Several problems here...

1. The comment is wrong -- a **32-bit** Windows "long" is 4 bytes, not 2...
2. A **64-bit** Windows "long" is ALSO 4 bytes but a pointer is 8!

Fortunately, this is a 64-bit Linux build where a "long" is 8 bytes...

# Example: Truncating CAST

MigraTEC Migration Workbench Project SED 64 Demo - [D:\SRC\SuSE\sed-3.02\lib\regex.c]

File Edit View Inventory Analysis Remediation Reports Bank Window Help

External Objects

- i386-pld-linux\3.1\crtbegin.o
- i386-pld-linux\3.1\crtend.o
- sed-3.02\lib\libsed.a
- sed-3.02\lib\libsed.a
- usr\lib\crt1.o
- usr\lib\crti.o
- usr\lib\crtn.o
- sed-3.02\lib\lib

File View Header View

Book Mark	Occ.	Name	File	Line	Issue Category
	+	ch	compile.c	989	
	+	highest_active_reg	regex.c	3872	
	+	len	regex.c	5448	Receives Trunc
	+	lowest_active_reg	regex.c	3871	
	-	mcnt	regex.c	3818	
		"	regex.c	3986	
		"	regex.c	3986	Cast Trunc int64 to 32
		"	regex.c	3986	

```
/* The starting position is bogus. */
if (pos < 0 || pos > size1 + size2)
{
    FREE_VARIABLES ();
    return -1;
}

/* Initialize subexpression text positions to -1 to mark ones that no
start_memory/stop_memory has been seen for. Also initialize the
register information struct. */
for (mcnt = 1; (unsigned) mcnt < num_regs; mcnt++)
{
    regstart[mcnt] = regend[mcnt] = old_regstart[mcnt] = old_regend[mcnt] = REG_UNSET_VALUE;

    REG_MATCH_NULL_STRING_P (reg_info[mcnt]) = MATCH_NULL_UNSET_VALUE;
    IS_ACTIVE (reg_info[mcnt]) = 0;
    MATCHED_SOMETHING (reg_info[mcnt]) = 0;
    EVER_MATCHED_SOMETHING (reg_info[mcnt]) = 0;
}

/* We move 'string1' into 'string2' if the latter's empty -- but not if
```

# Constants may conflict...

- 0xFFFFFFFF
  - is NOT equivalent to -1
  - is NOT INVALID\_HANDLE\_VALUE
- 0x80000000
  - is NOT a valid mask for system addresses (Windows drivers)
- Bit Masks (Unix longs)
- Rotate and Shift “counts” (Unix longs)

# Issue Detection

**0xFFFFFFFF and -1 are NOT equivalent in a 64-bit world!**

Book Mark	Occ.	"Remediation Choices" Candidate Name	From File	Line	Reason Found	Change?	Method	Basis	Target
4	-	SetClassLong	ms vc++6.0 win64 ia64.h	24	Seed Match	No	To Be Determined	N/A	N/A
5		"	PViewer.c	202		Yes	SetClassLong	API changes to	SetClassLongPtr
6		0xFFFFFFFF	PViewer.c	1031	Ext Constant				
7		0xFFFFFFFF	PViewdat.c	590	Ext Constant	Yes	Replace	0xFFFFFFFF	-1
8		" Total Commit"	PViewdat.c	589	Cast Trunc 64 to 32				
9	-	ByteLength	winperf.h	535					
10		"	Cntrdata.c	73	Cast Ext 32 to 64				
11	-	ByteLength	winperf.h	574					
12		"	Instdata.c	75	Cast Ext 32 to 64				
13		"	Cntrdata.c	125	Cast Ext 32 to 64				
14	-	ByteLength	winperf.h	613					

```
INT      InstIndex = 0;

ListIndex = SendMessage (hImageList, CB_ADDSTRING, 0, (DWORD)TEXT(" Total Commit"));
SendMessage (hImageList, CB_SETITEMDATA, ListIndex, 0xFFFFFFFF);

if (pImageObj)
{
    pImageInst = FirstInstance (pImageObj);

    while (pImageInst && InstIndex < pImageObj->NumInstances)
    {
        if (ParentIndex == pImageInst->ParentObjectInstance)
        {
            ListIndex = SendMessage (hImageList,
                                    CB_ADDSTRING,
                                    0,
                                    (DWORD) InstanceName (pImageInst));
```

**FIND it!**

**FIX it!**

Ln 590, Col 67

# New Windows API's

## Explicit 64-bit Functions, Types and Enumerates

```
SetWindowLong (_hWnd , DWL_USER , 1L) ;
```

Is replaced by:

```
SetWindowLongPtr (_hWnd , DWLP_USER , 1L ) ;
```

# Existing Types – New Sizes

Many were 32-bit, now 64-bit:

in Linux & Windows: **size\_t intptr\_t uintptr\_t**

in Windows: **LRESULT HANDLE LPARAM WPARAM**

NEW polymorphic (size variant) types for Windows

INT\_PTR (“an INT the size of a Pointer”)

Also:

UINT\_PTR, DWORD\_PTR,  
LONG\_PTR ULONG\_PTR, etc.



# Changed API Impacts

## Some common examples:

- C++ Parse Errors

“Return Type not covariant” and  
“Prototype does not match definition”

Ex. User procedure definition returning an INT at assignment to system defined structure member declared as intptr\_t

**And they're not always reported where the problem is clear!**

Ex. User DialogProc Definition

“Prototype does not match definition”

At assignment to WinClass struct member...

- API Parameters – “Pointer Type mismatches”

```
DWORD * -> intptr_t *  
unsigned long * -> uint *
```

```
DWORD * -> DWORD_PTR *  
unsigned long * -> ULONG_PTR *
```

# Issue Detection

Book Mark	Occ.	Name	File	Line	Issue Category	Change?	Method	Basis	Target	Comment
		0xFFFFFFFF	pviewdat.c	580	Suspect Constant					
	+	hWnd	pviewer.c	188						
	+	InstanceName	instdata.c	151						
		L" Total Commit"	pviewdat.c	579	Cast Trunc Ptr to 32					
		sizeof(DWORD)	perdata.c	210	Suspect sizeof					
	-	str	pviewer.c	1036						
		"	pviewer.c	1042	Cast Trunc Ptr to 32					
	+	str	pviewer.c	1084						
	-	szListText	pviewdat.c	878						
		"	pviewdat.c	912						
		"	pviewdat.c	914	Cast Trunc Ptr to 32					
	-	szListText	pviewdat.c	1037						
		"	pviewdat.c	1071						
		"	pviewdat.c	1076	Cast Trunc Ptr to 32					
	-	Tabs	pviewer.c	1257						
		"	pviewer.c	1260	Cast Trunc Ptr to 32					
		"	pviewer.c	1263	Cast Trunc Ptr to 32					
		wParam	pviewer.c	190	Auto Added					
	-	wParam	pviewer.c	190						
		"	pviewer.c	214	Cast Trunc 64 to <32					
		"	pviewer.c	226	Cast Trunc 64 to <32					
		"	pviewer.c	226	Cast Trunc 64 to <32					
		"	pviewer.c	237	Cast Trunc 64 to <32					
		"	pviewer.c	237	Cast Trunc 64 to <32					
		"	pviewer.c	241	Cast Trunc 64 to <32					
		"	pviewer.c	292	Cast Trunc 64 to <32					
		"	pviewer.c	311	Trunc int64 to 32					
		"	pviewer.c	339	Cast Trunc 64 to <32					

```

INT      ListIndex;
INT      InstIndex = 0;

ListIndex = SendMessage (hImageList, CB_ADDSTRING, 0, (DWORD)TEXT(" Total Commit"));
SendMessage (hImageList, CB_SETITEMDATA, ListIndex, 0xFFFFFFFF);

if (pImageObj)
{

```

Reason Found

Decision Support Grid

Code Context

# Source Code Browser

Book Mark	Occ.	Name	File	Line	Issue Category	Change?	Method	Basis	Target	Comment
		0xFFFFFFFF	pviewdat.c	580	Suspect Constant					
	+	hWnd	pviewer.c	188						
	+	InstanceName	instdata.c	151						
		L" Total Commit"	pviewdat.c	579	Cast Trunc Ptr to 32	Yes	Change Cast	DWORD	LPARAM	
		sizeof(DWORD)	perfddata.c	210	Suspect sizeof					
	-	str	pviewer.c	1036						
		"	pviewer.c	1042	Cast Trunc Ptr to 32	Yes	Change Cast	DWORD	LPARAM	
	+	str	pviewer.c	1084						
		szListText	pviewdat.c	878						
		"	pviewdat.c	912						
		"	pviewdat.c	914	Cast Trunc Ptr to 32	Yes				
	-	szListText	pviewdat.c	1037						
		"	pviewdat.c	1071						
		"	pviewdat.c	1076	Cast Trunc Ptr to 32	Yes				
	-	Tabs	pviewer.c	1257						
		"	pviewer.c	1260	Cast Trunc Ptr to 32	Yes				
		"	pviewer.c	1263	Cast Trunc Ptr to 32	Yes				
		wParam	pviewer.c	100	Auto Added	Yes				
	-	wParam	pviewer.c	190						
		"	pviewer.c	214	Cast Trunc 64 to <32					
		"	pviewer.c	226	Cast Trunc 64 to <32					
		"	pviewer.c	226	Cast Trunc 64 to <32					
		"	pviewer.c	237	Cast Trunc 64 to <32					
		"	pviewer.c	237	Cast Trunc 64 to <32					
		"	pviewer.c	241	Cast Trunc 64 to <32					
		"	pviewer.c	292	Cast Trunc 64 to <32					
		"	pviewer.c	311	Trunc int64 to 32	No	To Be Determined	NA	NA	
		"	pviewer.c	339	Cast Trunc 64 to <32					

**Fix the truncating cast!**

**Automated solution selection!**

**Uses Data Flow analysis to identify Macro and required data type!**

```
INT ListIndex;
INT InstIndex = 0;

ListIndex = SendMessage (hImageList, CB_ADDSTRING, 0, (DWORD)TEXT(" Total Commit"));
SendMessage (hImageList, CB_SETITEMDATA, ListIndex, 0xFFFFFFFF);

if (!pImageObj)
```

Propagate Relationships: <ListIndex>

- ListIndex
- wParam
- wParam
- SendMessageW
- SendMessageW

LRESULT (HWND, UINT, WPARAM, LPARAM) - 8 bytes

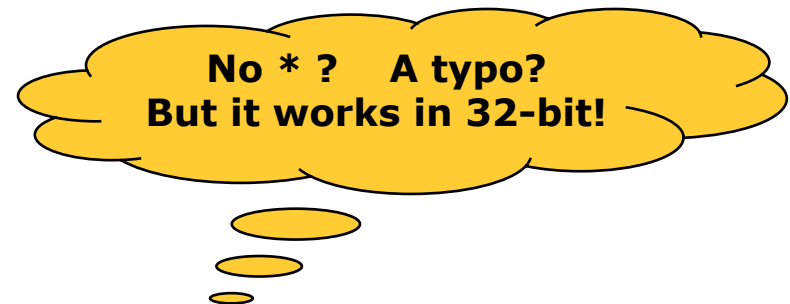
**View the Definition to understand the reason..**

## malloc & similar memory functions

```
LONG ** pThing;
```

Wrong or Unsafe:

```
pThing = malloc ( 4 );  
pThing = malloc ( sizeof ( LONG ) );
```



Better:

```
pThing = malloc ( sizeof ( pThing ) );
```

Right:

```
pThing = malloc ( sizeof ( LONG * ) );
```

# Offsets into Pointer Arrays

Fixed byte offsets may fail...

```
int *    pThree;  
struct { int iCount; int * iArray [ 6 ] } ptrS;  
pThree = (char)ptrS + 16;
```

*alignment shifts iArray by 4 to 8 byte align*

*( 4 bytes are skipped after "iCount" )*

*each iArray int \* is now also 8 bytes – "pThree" is now "pTwo"*

Even sized offsets may be wrong...

```
pThree = ( char ) ptrS.iArray + 3 * sizeof ( int );
```

*in 32-bit, sizeof( int ) = sizeof( int \* ) -- no problem*

*in 64-bit, this hidden error will be exposed...*

***But the compiler will miss both of these!***

# Unions - Implicit AND Explicit

- Explicit Union - completely declared  
each must use types with equivalent sizes
- Implicit Union  
two "struct" declarations, passed by void \*  
BOTH must use types with equivalent sizes

*The compiler will miss this as well!*

# 8-byte pointer alignment

## Packed Data with embedded pointers

- misaligned pointers will cost a cycle or two  
*(On Itanium, they cause Run Time errors!)*
- “filler” bytes may be incorrect

Un-packed data may waste memory when compiler pads to 8-byte alignment

Files sharing structure definitions and compiled packed may misalign with un-packed code

# I/O with 64-bits of data

Old data content may not be compatible!  
Likely to impact design or require coding...  
How?

1. Preserve old code to read old files/data  
( It will require explicit 32-bit data types !)
2. Add Sizing information to data
3. Ifdef for 32-bit or 64-bit only
4. Merge "split" files to use 64-bit offsets



- Mixed signed/unsigned with extensions  
*(Use UNsigned unless you **MUST** have negatives)*
- Precision Loss of 64-bit to Double
- “MAX” constant values
- Type specifications on printf, scanf, etc.
- 16-bit APIs in Windows Drivers
- Inline Assembly
- `#ifdef Alpha` ( to enable 64-bit code )

## Compiler / Lint warning “clutter”

- Truncation to Less than 32-bits
- Extension from Less than 32-bits
- non-pointer 32 to 64 Extension Warnings
- Casts to match API types

# Project Process Model

## **Project Initiation**

Inventory, ROI,  
Risk analysis, Go/no-go

## **Project Planning**

Requirements, Scope, Sizing,  
Resources, QA Specs

## **Code Migration**

Analyze, Remediate, Build

## **Testing/QA**

Unit Test, Correction, Performance Tuning,  
System Test, Acceptance

# Problem Corrections EDITED into NEW source files

*The coding style is preserved!*

```
D:\SRC\Windows\PViewer\pviewdat.c

PPERF_INSTANCE pImageInst;
// INT ListIndex;
INT_PTR ListIndex;
INT InstIndex = 0;

// ListIndex = SendMessage (hImageList, CB_ADDSTRING, 0, (DWORD)TEXT(" Total Commit")); MT64:O
ListIndex = SendMessage (hImageList, CB_ADDSTRING, 0,
    (LPARAM)TEXT(" Total Commit")); // MT64:M
// SendMessage (hImageList, CB_SETITEMDATA, ListIndex, 0xFFFFFFFF); MT64:O
SendMessage (hImageList, CB_SETITEMDATA, ListIndex, -1); // MT64:M

if (pImageObj)
{
    pImageInst = FirstInstance (pImageObj);

    while (pImageInst && InstIndex < pImageObj->NumInstances)
    {
        if (ParentIndex == pImageInst->ParentObjectInstance)
        {
            ListIndex = SendMessage (hImageList,
                CB_ADDSTRING,
                0,
                (DWORD)InstanceName(pImageInst)); MT64:O
            (LPARAM)InstanceName(pImageInst)); // MT64:M
            SendMessage (hImageList, CB_SETITEMDATA, ListIndex, InstIndex);
        }
    }
}
```

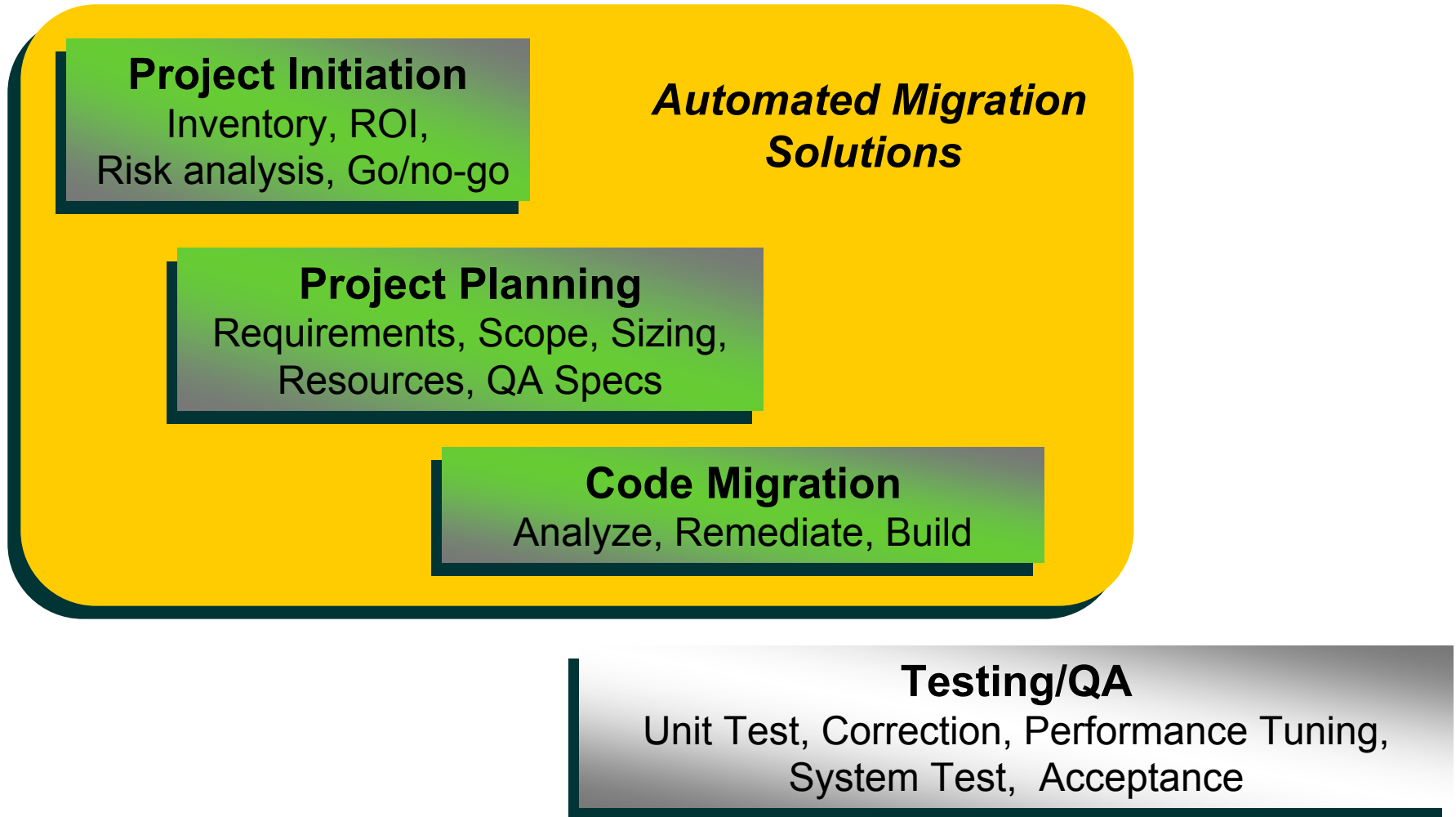
Type changed!

Audit Tags!

Constant corrected!

Casts corrected!

# Project Process Model



## Pre-release Tasks

- Unit Test (Minimized by thorough analysis!)
- Defect Correction (Nobody's perfect...)
- Performance Tuning (Today's pre-release experience...)
  - *For x86-64 it's probably only necessary if the 32-bit version needed it!*
  - *For Itanium it's essential – the compiler has no knowledge of run-time usage, the processor does nothing to help and a profiler guided optimization is almost unavoidable.*
- System Test
- Acceptance

# Reporting for Test and Audit

## Inventory Summary Report

Project Name: SED 64 Demo

### Project Information

Project Type: Linux 32 to 64 bit Project  
Project Location: DATEMP  
Project Description:

### File Information

Lines of Code: 11,128  
Source: 6,601  
Included Files  
User: 461  
System: 4,066

Total LOC Charged: 7,062

### Error Information

Compiler Issues: 6  
Missing Files: 0

8/14/2002 8:32:56AM

Report Format Version 03/30/01

## Analysis Issue Summary Report

Project Name: SED 64 Demo

Total Number of Files with Issues: 3

Total # of Issue Occurrences: 73

Issue Category	# of Issue Definitions per Issue Category	# of Files per Issue Category	# of Issue Occurrences per Issue Category
Receives Truncated Values	5	1	5
Truncations of Pointers to 32-bit	0	0	0
Truncations of 64-bit ints to 32-bit	3	1	5
Truncations of Pointers Cast as 32-bit	0	0	0
Truncations of 64-bit ints Cast as 32-bit	1	1	5
Pointer Type Mismatch	0	0	0
Function Pointer Type Mismatch	0	0	0
Precision Loss of 64-bit to Double Type	0	0	0
Suspect Left-shifts	1	1	1
Suspect Constants	0	0	0
Extensions to 64-bit of mixed signed/unsigned 32-bit	8	3	12
Suspect sizeof (32-bit Type)	2	1	2
In-line assembly code	0	0	0
Extensions of 32-bit to Pointers	1	1	1
Extensions of 32-bit to 64-bit ints	7	2	10
Extensions of 32-bit Cast as Pointers	1	1	1
Extensions of 32-bit Cast as 64-bit ints	3	2	5
Truncations of 64-bit to Smaller-than 32-bit	4	2	6
Truncations of 64-bit Cast as Smaller-than 32-bit	0	0	0
Extensions of Smaller-than 32-bit to 64-bit	4	1	19
Extensions of Smaller-than 32-bit Cast as 64-bit	0	0	0
Candidates that Matched Items in the Seed List	0	0	0
Defined by User	1	1	1
Added by Workbench	0	0	0

8/14/2002 8:27:24AM

Report Format Version 07/24/02

Page: 1

# Recipe for Disaster

“Just re-compile it for the target and fix the errors..”

The compilers are NEW  
(even from the same vendor )

Expect to see:

- ANSI compliance issues.
- Unsupported extensions
- New command line arguments
- New and different optimization tools



# Benefits of Automated Migration Solutions

***Migrating applications to 64-bit does not need to be an error-prone and tedious process!***

## **Automated Migration Solutions:**

- Provide a Predictable, Manageable Process
- Utilize already proven applications
- Reduce Time-to-Market
- Reduce Migration Costs
- Improve application quality
- Have multiple file AND application scope!
- Provide Documentation for Audit & Test Planning

# How good is it?

## “Widening the Nile”

MSDN Magazine and PDC Presentation

<http://msdn.microsoft.com/msdnmag/issues/01/11/XP64/XP64.asp>

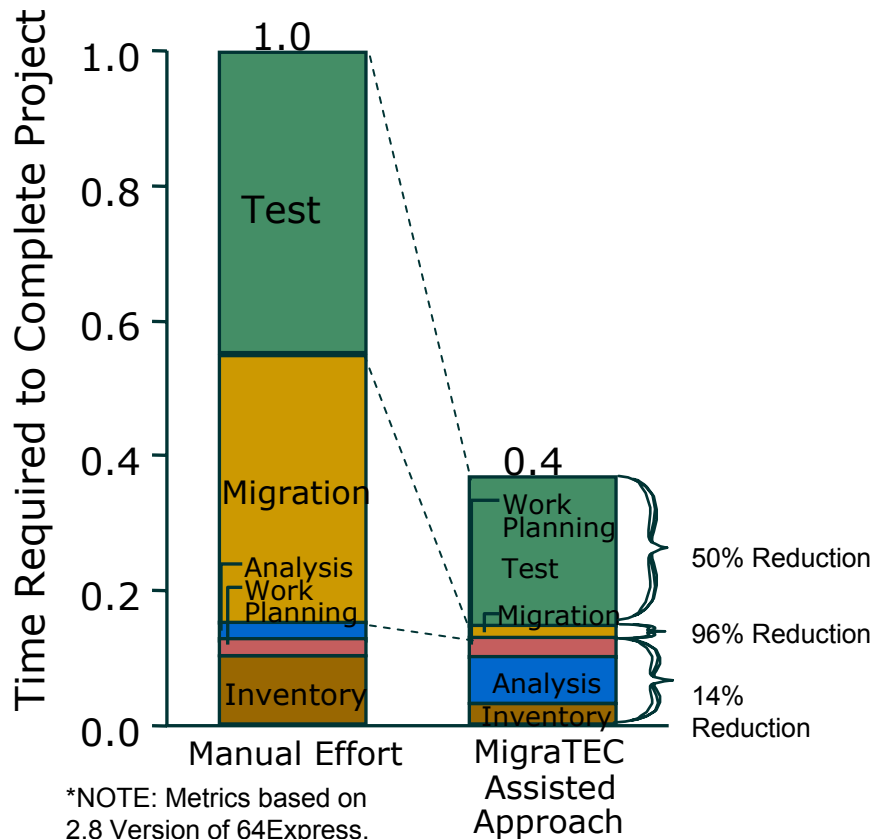
- Stated that 3 Microsoft engineers needed only “one programmer-week” (40 hours?) to complete the port (3 server applications)
- One MigraTEC engineer downloaded the same source code and had it fully migrated in 3 hours with MigraTEC’s *64Express*<sup>TM</sup>
- Additionally, 64Express identified two errors and multiple inconsistencies of applied solutions that manual porting missed and 1 bug introduced by a typographical error

**Manual effort: 40 hours**  
**Automated effort: 3 hours**



# Value Creation

*In addition to enabling a predictable process, MigraTEC's 64-bit migration solutions have saved more than 50% of the time (and cost) to complete a typical (500,000 line) migration project.*



## Sample Performance Metrics

- 200,000 lines of AMD code with MigraTEC technology in 1 week vs. a 4 week manual effort
- 750,000 line project completed in 40 man days by team of MigraTEC and client engineers
- MigraTEC migrates 150,000 line project for customer in 7 man days
- 140,000 lines of device driver code, 50,000 lines with identified 32-bit/64-bit issues, estimated at least 9 weeks to complete in-house using a manual approach project -- completed by MigraTEC in 4 weeks

# MigraTEC Two Step

## 2-Step Methodology

*Experience has proven the “short-cut” introduces unacceptable risk due to differing problem domains!*



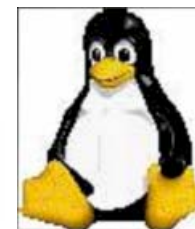
Step 1: **32Direct™**

**32-to-32 Cross Platform  
(Solaris32 to Win32)  
(Solaris32 to Linux32)**



Step 2:  
**64Express™**

**32-to-64 Upgrade  
(Win32 to Win64)  
(Linux32 to Linux64)**



- **Migrating C/C++ to 64-bit White Paper**

Available – pick one up

Also on AMD and MigraTEC web sites

- **AMD Developer Lab**

## *Migration Technology Solutions - Products and Services -*

**32-bit to 64-bit Migration**    using    **64Express™**  
**Cross Platform Migration**    using    **32Direct™**

***Support for a variety of migration paths is available.***

***Visit: [www.migratec.com](http://www.migratec.com)***

***Call: 1-800-678-5187***

***MigraTEC, Inc.      11494 Luna Road      Dallas, TX 75234***

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